U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

Closeout Report on the DOE/SC CD-3a Review of the

Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment (LBNF/DUNE) Project

Sanford Underground Research Facility

December 2-4, 2015

Stephen W. Meador

Committee Chair

Office of Science, U.S. Department of Energy

http://www.science.doe.gov/opa/

Review Committee Participants

Stephen W. Meador, DOE/SC, Chairperson

SC1
Detectors

* Marty Breidenbach, SLAC

SC2
Cryogenic

* Matt Howell, ORNL
Brian DeGraff, ORNL

SC3
Conventional Facilities

* Jack Stellern, ORNL
Adrienne Carney, U of Pitt

SC4
Environment, Safety and Health

* Ian Evans, SLAC

SC5
Cost and Schedule

* Angus Bampton, PNNL
Jennifer Fortner, ANL
John Post, LLNL

SC6
Project Management

* Jim Krupnick, retired LBNL
Kurt Fisher, DOE/SC
Lynn McKnight, TJNAF

Observers

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LEGEND

SC Subcommittee
* Chairperson

Count: 13 (excluding observers)

Charge Questions

1. Is the Far Site Conventional Facilities (CF) design technically sound and sufficiently mature to support proceeding with procurement and initiation of initial civil construction activities? Does the design flow down from the requirements? Have technical risks been appropriately addressed? Has the interface definition between CF and the cryostat/cryogenic systems and CF and the detector, as well as the logistics of excavation, construction, and technical systems installation, been sufficiently developed?

2. Is the CD-3a scope identified by the project necessary and sufficient to enable installation of the cryostat, cryogenic infrastructure, support systems and detector?

3. Are the cost and schedule for initial far site construction activities credible, with adequate contingencies? Does the project have a credible plan to track performance associated with these activities? Are risks identified and managed appropriately?

4. Are ES&H aspects being properly addressed and are future plans sufficient given the project's current stage of development?

5. Is the project being effectively managed? Is it properly organized and staffed to successfully execute project plans, especially as they relate to the initiation of Far Site construction activities?

6. Has the project responded appropriately to recommendations from the last DOE review, in particular, in relation to the Far Site CF?

7. Is the project ready to seek approval of CD-3a to initiate Far Site construction?

2.1 Detectors

M. Breidenbach, SLAC / Subcommittee 1

1. Is the Far Site Conventional Facilities (CF) design technically sound and sufficiently mature to support proceeding with procurement and initiation of initial civil construction activities? Does the design flow down from the requirements? Have technical risks been appropriately addressed? Has the interface definition between CF and the cryostat/cryogenic systems and CF and the detector, as well as the logistics of excavation, construction, and technical systems installation, been sufficiently developed?

- The FSCF design is well matched to the requirements of the four 10 kt fiducial mass DUNE detectors and their technical support facilities, primarily cryogenics, electrical power, ventilation, and safety.

- The design for the DUNE detectors flows from the P5 vision of significant discovery potential for neutrino oscillation physics, nucleon decay, and detection of neutrinos from galactic core collapse supernovae. The DUNE detectors should meet the specific P5 goal of 120 kt-MW-yrs by 2035, and are clearly expandable to 40 kt.

Technical risks associated with the detector do not significantly affect FSCF. See Comments.

The interface definition between the cryogenics/cryostat and the detector is adequate for FSCF.

The interface definition between CF and the detector is adequate, but there may be possibilities for modest cost savings.

The logistics of technical systems installation for the first detector cryostat is credible, but LBNF/DUNE should continue to work on possible interference between installation and further excavation.

Summary: Yes

2. Is the CD-3a scope identified by the project necessary and sufficient to enable installation of the cryostat, cryogenic infrastructure, support systems and detector?

   Yes.

6. Has the project responded appropriately to recommendations from the last DOE review, in particular, in relation to the Far Site CF?

   Yes

7. Is the project ready to seek approval of CD-3a to initiate Far Site construction?

   For detector considerations, yes.

- 2.1.1 Findings
  1. LBNF/DUNE has carried out the P5 mandate exceptionally well in forming a highly functioning international collaboration.
  2. The design of DUNE should meet the physics goals of P5.
  3. ProtoDUNE is critically important for the demonstration of DUNE technology before CD-2, and is being built by the Far Detector group.
  4. The collaboration has responded appropriately to the CD-1r recommendations:
     1. A new photon detector with ~4x better efficiency has been adopted as the baseline.
     2. An effort is underway to increase the U.S. university collaboration.
     3. A technique has been developed to He leak check the cryostat seams; there will be experience with several smaller cryostats; and the foam will be purged with Ar.
  5. Many projects including LBNF/DUNE seem short of critical engineering skills.

- 2.1.2 Comments:

1. Although the international collaboration is proceeding well, it is noted that Japan has not significantly joined. Much of the HEP community is convinced that large projects need tri-regional cooperation both for expertise and financial contributions.
2. The involvement of CERN is critically important, and notable in that it is CERN's first non-European venture.
3. CERN is leading the effort to develop two phase detectors at WA-105 as an option for the subsequent detectors.
4. The CD-3a cavern construction should trigger more international involvement.
5. The shortage of critically skilled engineers is putting excessive stress on the few experts in the community.
6. First results from ProtoDUNE are expected in Q2 2018, and will provide valuable input to validate the detector design before CD-2. Support for U.S. scientists at CERN for Proto-DUNE seems marginal.

6. Aspects of the detector grounding scheme and power budget could be re-examined for potential cost savings.
7. There is continuing concern about controlling radioactive backgrounds such 222Rn. Better understanding of requirements and comprehensive purity testing of detector components seems advisable.
8. There appears to be significant technical data arising from the operating set of LAr TPC's that is not being communicated very well.
9. There appears to be healthy cooperation with SBND on cold electronics.

- 2.1.3 Recommendations
  1. FNAL management should encourage better communication among the LAr TPC groups, perhaps with understandings that the information is privileged.
  2. DOE and the labs should consider plans to increase the supply of critically needed engineers.
  3. DUNE, FNAL, and DOE should consider plans to ensure adequate U.S. involvement in ProtoDUNE to ensure technical readiness at CD-2.
  4. LBNF/DUNE is ready to proceed to CD-3a.

Committee Members: Brian DeGraff-ORNL, Matt Howell-ORNL

1. Is the Far Site Conventional Facilities (CF) design technically sound and sufficiently mature to support proceeding with procurement and initiation of initial civil construction activities? Does the design flow down from the requirements? Have technical risks been appropriately addressed? Has the interface definition between CF and the cryostat/cryogenic systems and CF and the detector, as well as the logistics of excavation, construction, and technical systems installation, been sufficiently developed? **YES**

2. Is the CD-3a scope identified by the project necessary and sufficient to enable installation of the cryostat, cryogenic infrastructure, support systems and detector? **YES**

6. Has the project responded appropriately to recommendations from the last DOE review, in particular, in relation to the Far Site CF? **YES**

7. Is the project ready to seek approval of CD-3a to initiate Far Site construction? **YES, after addressing the following recommendation.**

- **Findings**
  - The cryogenic and cryostat systems are being designed by a strong, collaborative team primarily from Fermilab and CERN.
  - The cryostats are on the critical path schedule.
  - The cryogenic systems are very near the critical path schedule.
  - CD-3a scope includes central utility cavern and the detector cavern for detectors 1 and 2. The cavern for detectors 3 and 4 is part of CD-3c.
  - One key goal for the project is to be ready to install Detector 1 in 2021.
  - Many prototype efforts are underway for the cryostat which reduces overall risk to the project.
  - The Interface Control Documents that define the interface between cryogenics and conventional facilities are in place.
  - Change control is in place to capture any changes to the CD-3a requirements.
  - Liquid nitrogen storage provides 40 hours of back up cooling in the event of a loss of power.
  - At the 4850L, back up power is only provided to cryogenic controls within the cryogenic system.

- **Findings**
  - Summary of changes since CD-1R
    - Cryostat
      - CERN has officially taken responsibility of 1 cryostat.
      - The steel support is lighter due to re-design following ASME BPVC Section VIII Div. 2.
      - The longest pieces of the steel support structure have been reduced to facilitate transportation through the shaft.
      - A study is being conducted to install the detector from the side of the cryostat rather than the top.
    - Cryogenic System
      - The refrigeration capacity has changed from four 85kW units to four 97kW units.
      - This increase in capacity did not affect power or size requirements because it resulted from improved LN2 cycle design.
      - A mezzanine was added to the top of each cryostat

- **Findings**
  - Summary of changes since CD-1R continued
    - Cryogenic System
      - A control engineer has been allocated to the project to advance the process controls design.
      - The LN2 storage dewars have been moved from the central utility cavern to the drift to reduce the size requirement.
  - Summary of the cryogenic requirements given to conventional facilities
    - **Space requirements:**
      - LAr/LN2 receiving stations: outdoor space for truck receiving, LAr/LN2 vessels and vaporizers per Doc DB n. 248.
      - Compressors Building: **32.4 m (L) x 12.8 m (W) x 6.1 m (H)**.
      - Shaft: CF to provide **2 x 16”** pipes (Low Pressure GN2), **3 x 8”** pipes (2 for High Pressure GN2, 1 for GAr). All pipes are carbon steel and connected with Victaulic couplings. Pipes provided by CF (per cryogenics design) go from outside of compressors building to Central Utility Cavern.

- **Findings**
  - Summary of the cryogenic requirements given to conventional facilities cont'd
    - **Space requirements:**
      - Central Utility cavern: **138.5 m (L) x 19.7 m (W) x 10.85 m (H).**
      - Detector's Cavern: Minimum **69.6 m (L) x 19.7 m (W) x 28.0 m (H)** and able to support a **25 m (L) x 10 m (W)** mezzanine (one per cryostat) with floor and point loading per DocDB n. 583. Space for LAr pump towers and piping: **3.3 m (L) x 19.7m (W)** on the side towards the central drifts.
      - Drifts: space in the crown for LN2/LAr pipes connecting the Central Utility Cavern and the Detector's Cavern, the GAr/GN2 returns and the vents to the Oro Hondo shaft. Space for the LN2 storage dewars in the crown of the drift on the east side of the Central Utility Cavern, with interconnecting piping.

- **Findings**
  - Summary of the cryogenic requirements given to conventional facilities cont'd
    - **Installation and logistics:**
      - Logistics: components will fit within the constraints of the Ross Shaft either as individual units or broken down in parts and assembled underground.
      - Detector Cavern access: independent of those for detector installation and cryostat installation.
    - **Ventilation:**
      - General to allow materials flow as needed.
      - Detector's cavern greater than 10,000 m^3/hr (minimum for ODH).
      - Central Utility Cavern greater than 15,000 m^3/hr (minimum for ODH).
      - Ross Shaft greater than 90,000 m^3/hr (minimum for ODH).

- **Findings**
  - Summary of the cryogenic requirements given to conventional facilities cont'd
    - **Electrical Power:**
      - Compressors: 4 x 1,500 hp.
      - Boosters: 4 x 150 hp.
      - More contributions (lower values) in power table on DocDB n. 208 (also on review website under "Far Site CF/Design Requirements").
    - **Heat Rejection:**
      - Compressors: 3,600 kW to cooling water, 764 kW to room.
      - Boosters: 400 kW to cooling water, 82.4 kW to room.

- **Comments**
  - The team is doing an exceptional job of preparing for CD-3a and is to be congratulated. However, the pace of the project is aggressive.
  - Because the project is moving forward with CD-3a before a baseline design is established, there is some inherent risk. The risk is adequately captured in the risk registry.
  - At this point, it appears that the cryogenic system has adequate capacity margin. Prototyping efforts are giving good confidence in the load requirements.
  - Documents were updated to reflect the changes since CD-1R but some discrepancies were noticed such as the leak detection method for the cryostats detailed and the number of nitrogen dewars in Cryo Infrastructure Design Report.
  - Verify that all of the ICDs have approval signatures.
  - There is no current plan for back up power to the booster compressors to provide some reduced refrigeration capacity in the event of a prolonged power outage (>40 hours).
  - The committee encourages formalizing agreements for the non-DOE scope.

- **Comments**
  - Given the possibility of increased refrigeration capacity, one compressor and refrigerator will serve as an in-line spare.
  - It was deemed too early in the project to bring on operations staff for cryogenic systems. However, a couple of critical positions to participate in final design and commissioning would be beneficial to the operability and sustainability of the facility.
  - Controls design should proceed to mature to the level of the rest of the cryogenic system design.
  - There are additional detailed design iterations being considered for ODH safety such as secondary containment around the liquid argon piping at the base of the cryostat. Exploring these considerations will progress as the project moves towards CD-2.
  - Valves and distribution piping is going to require significant space. There is a plan of where to locate these. However, it is not identified in the 3D model at this point.
  - The argon receipt storage capacity seems limited given the amount of deliveries required and the likely weather delays. Argon delivery logistics planning will continue.

- **Recommendations**
  - Consider adding back up power to the booster compressors to allow some reduced capacity refrigeration operation in the event of a sustained power outage prior to CD-3a.
  - Given the complexity of operation and the difficulty in recruiting cryogenic resources, develop a cryogenic and cryostat systems operations staffing plan that intentionally hires a few key positions in advance of critical cryogenic system design milestones in the project prior to CD-2.
  - Ready to proceed to CD-3a.

3. Conventional Facilities

J. Stellern, ORNL /A. Carney retired CONSOL

Subcommittee 3

Charge Questions:

1. Is the Far Site Conventional Facilities (CF) design technically sound and sufficiently mature to support proceeding with procurement and initiation of initial civil construction activities? Does the design flow down from the requirements? Have technical risks been appropriately addressed? Has the interface definition between CF and the cryostat/cryogenic systems and CF and the detector, as well as the logistics of excavation, construction, and technical systems installation, been sufficiently developed? Yes

6. Has the project responded appropriately to recommendations from the last DOE review, in particular, in relation to the Far Site CF? Yes

7. Is the project ready to seek approval of CD-3a to initiate Far Site construction? Yes

Findings:

- The preliminary design has been completed on the CD3A scope. The design documents have been reviewed by the team and by an independent review team, these comments will be incorporated into the final design. A final design plan has been issued documenting the activities and schedule to complete the final design.
- The RFP for the CM/GC has been prepared and issued to DOE for approval. The CM/GC award is scheduled for mid-June 2016.
- The project has a robust process to track the science requirements flow down to conventional facilities. Interface Control Documents between CF and the science disciplines have been prepared and approved.
- The project has not closed out all previous review recommendations but the remaining items are in process and are being tracked.

3. Conventional Facilities

J. Stellern, ORNL/A. Carney retired CONSOL

Subcommittee 3

Findings:

- The LBNF Team performed a thorough 2 phase geotechnical investigation building on extensive historical information from mining and prior preliminary designs/studies (e.g. DUSEL), and including information from 4 new core holes.
- NCAB reviewed the project's geotechnical information and cavern plans
- A comprehensive test blast is planned to further characterize areas of interest near planned excavations, and for measuring potential impact on existing science users/operations
- Numerous excavation models/alternatives examined led to selecting the preferred excavation approach that was presented
- Waste rock is planned to be disposed in the Open Cut using an overland conveyor system
- Underground Infrastructure needs have been identified and characterized including: shaft modifications in the Ross for underground utilities; the brow needed at 4850 to accommodate cryostat steel members; and new conveyances needed for waste rock handling and construction support

3. Conventional Facilities

J. Stellern, ORNL/A. Carney retired CONSOL

Subcommittee 3

Findings:

- Ventilation requirements for the entire mine and planned excavations at 4850 have been translated into ventilation plans facility wide; for construction; and HVAC for lab spaces.
- A water inflow program has been ongoing since reopening the mine to develop the research areas – Water inflow averages 700 gpm
- Installation of 2000’ HDPE pipe to direct water to the #5 shaft is planned.
- The project has considered identification of potential additional easements and/or property acquisitions needed to manage laydown areas and deliveries of materials off site due to existing real estate constraints.
- Logistics workshops have been conducted.

Comments:

- The preliminary design is technically sound and sufficiently mature to support proceeding with the CM/GC procurement.
- The procurement schedule for the CM/GC is based on a best case scenario. Any delays in the award would delay the CM/GC review and estimate of the 30% final design package and delay the scheduled award of the pre-excavation construction package.
- The design is based on the cryostat/cryogenic systems and detector science requirements flowed down to CF in the interface control documents.
- The project should consider having a representative of the AE on site during construction to improve coordination between all parties including timely evaluation of field problems, RFIs, submittal reviews, etc.
- ARUP will prepare Basis of Design and Concept of Operations plans during final design. This is a good practice and will be very valuable to SURF.

3. Conventional Facilities

J. Stellern, ORNL/A. Carney retired CONSOL

Subcommittee 3

Comments:

- Based on the review of a thorough two phase geotechnical investigation which was constructed on the basis of a detailed investigation of existing mine entries with the drilling of new coreholes; the project should consider using the data from the ongoing model to continue to engage the neutrino cavern advisory board during construction to potentially mitigate any unknown anomalies.
- The project should consider further examination of the logistics and development of additional detailed plans. Engage the CM to prepare the logistics plan when the contract is awarded.
- The project should consider the method or system for maneuvering and/or loading/reloading steel components for transport in the shaft bottom area. The project should consider identification of “pinch points” where materials in transport on mine cars could become iron bound/trapped/stuck?

3. Conventional Facilities

J. Stellern, ORNL/A. Carney retired CONSOL

Subcommittee 3

Comments:

- The project is considering development of a plan for the installation of a temporary waste rock conveyor system. The committee supports evaluation of a conveyor system.
- The project should continue further define, study, and manage impounded water throughout the mine.
- The project should continue investigating the mining and constructability issues as preparation to work with the CMGC.
- The project should consider development of a maintenance plan for the slick lines, “pigging” the lines for obstructions after each use.
- The project team should view the project not only as construction but also as a mining activity and consider developing a mining risk analysis.

3. Conventional Facilities

J. Stellern, ORNL/A. Carney retired CONSOL

Subcommittee 3

Recommendations:

The project is ready to proceed to CD-3A.

4. Are ES&H aspects being properly addressed and are future plans sufficient given the project's current stage of development?

   Yes

6. Has the project responded appropriately to recommendations from the last DOE review, in particular, in relation to the Far Site CF?

   In large, awaiting one final report on state of ventilation paths.

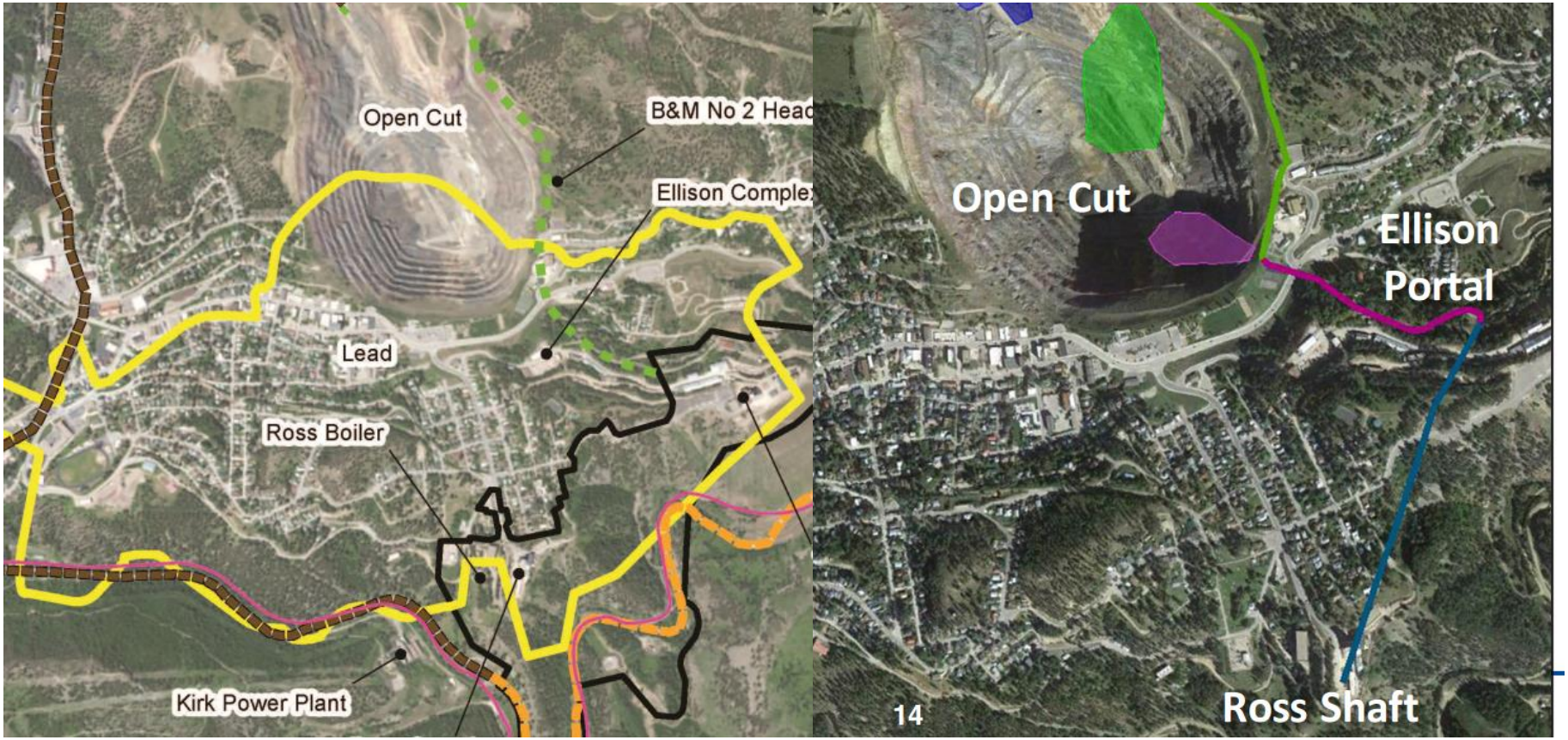
7. Is the project ready to seek approval of CD-3a to initiate Far Site construction?

   Yes

- **Findings**
- Documentation to support the present stage of the Project is complete
- EA commitments have been documented.
- Separation of leased space and ESH requirements is well understood by all parties.
- Conventional Facilities construction at SURF will be accomplished through a Construction Manager/General Contractor (CM/GC) contracting methodology in which the CM/GC holds the trade subcontracts.
  - 10CFR851 requirements will be flowed to CM/GC and lower tier subs.
  - CM/GC ESH requirements defined in RFP, consistent with other large DOE construction projects
- Project and SURF staff are addressing comments from Directors Review
- Capable and experienced ESH staff are present in both the Project and SURF.
- SURF Emergency Management Team is accomplished, trained and appropriately staffed to accommodate construction activities.
- Weekly Science Integration meetings are ongoing. These keep the Science community abreast of activities; i.e. proposed test blast activities

- **Comments**
- Recommendations from the previous review have in large been addressed.
  - FNAL Large Detector Cryogenic Safety Committee has reviewed the preliminary ODH analysis, this will continue through final design.
  - Awaiting final report on risks associated with potential restrictions to the exhaust ventilation circuit.
- The plan to dispose of rock into the open-cut is commendable with respect to eliminating ~40000 truck trips, but the disposition map presented is inconsistent with the Historical District documented in the EA. The EA is a Record of Decision and binds the Project in what is has stated it will do.
- Through discussions it appears that SURF is integrated to some extent in Project ESH document review, however, there is no way to recognize what SURF has concurred with.
  - As an example the Project Integrated Safety Management Plan has expectations of delivery by SURF management, but is only signed by Project staff.
- The ODH assessment follows the FNAL (FESHM) methodology, firmly classifying all areas at ODH Classification Level 1. This provides a minimum set of controls (mitigations) as the Project moves forward. It was unclear if the ODH level was also applied to areas which will be considered confined spaces.

- **Comments**
- It was unclear if provisions in the DOE Explosives Manual (called in under 851) are consistent with State and Facility requirements.
- The risk registry identified an ESH incident as a risk that could produce a schedule impact, but no cost impact. Under the CM/GC concept this may well be true for the Project, because by default the CM/GC owns the risk, however it should be made abundantly clear upfront that DOE could impose schedule delays via their own investigation of serious incidents of injuries, that may translate into dollars.


Open Cut
B&M No 2 Head
Ellison Complex
Lead
Ross Boiler
Kirk Power Plant
Open Cut
Ellison Portal
14
Ross Shaft

- **Recommendations**

- Complete revision of Homestake Mining Permit 332 and agreement between SURF & Homestake to manage the rock disposition into the open cut.
- Review and revise open-cut disposition plan to ensure consistency with the Environmental Assessment (the Record of Decision).
- Clarify in the ODH design analysis whether all aspects of the Project spaces will be ODH Hazard Classification Level 1 and whether further mitigation (controls) will be employed for work activities on cryogenic systems and confined spaces.
- Provide a signature concurrence line on all documents that can affect SURF facility design, existing infrastructure interfaces or expectations of delivery by SURF team.
- Perform a gap analysis of the DOE Explosives Manual, and South Dakota State (BATF) and SURF requirements. (Prior to CM/GC award)
- Provide guidance to CM/GC bidders on Incident/Injury reporting requirements, DOE's ability to stop work, invoke penalties and sequential re-start path. (Companies with no Federal experience will need enlightenment)
- Project is ready to proceed to CD3a

3. Are the cost and schedule for initial far site construction activities credible, with adequate contingencies? Does the project have a credible plan to track performance associated with these activities? Are risks identified and managed appropriately? Yes

6. Has the project responded appropriately to recommendations from the last DOE review, in particular, in relation to the Far Site CF? Yes

7. Is the project ready to seek approval of CD-3a to initiate Far Site construction? Yes

- **Findings**
- Cost estimate
  - Cost profile for CD-3a scope

$M	FY17	FY18	FY19	FY20	FY21	TOTAL
CD-3a Obligations	15	42	80	75	7	219
CD-3a Contingency	6	16	30	28	3	83
Total	21	58	110	103	10	302

DESCRIPTION	BCWS ($M)
Far Site Conventional Facilities Construction	219
FSCF Construction Management	26
Pre-Excavation (Pre-EXC)	49
Cavern & Drift Excavation (EXC)	102
Buildings & Site Infrastructure (BSI)	42
Contingency need	83
CD-3A TOTAL REQUEST	302

- CD-3a request includes the base cost and contingency for 80% construction of far site conventional facilities. Ongoing labor and overall project PED is not included.
- Drill downs conducted on $171M of the $219M of CD-3a scope.
- The estimate is supported by detailed independent cost estimates prepared by Arup on the 100% preliminary design. Reconciled twice – 5%
- Linkage between the cost books, P6 Resource Loaded Schedule and the Arup cost estimate was presented.
- Cost estimate includes appropriate Fermilab burdens. Overhead rates tailored to reflect funding - OPC, PED, Construction.
- Escalation rates for Labor and M/S in accordance with Fermilab guidance.
- Escalation for construction has been determined based on independent analysis.

- **Findings, cont.**
- Schedule/EVM
  - CD-3a proposed work comprises of 769 resource-loaded activities within four control accounts under the Far Site Conventional Facilities (FSCF) WBS. The entire FSCF WBS will be put under an internal baseline and used for reporting EVM.
  - The critical path for FSCF begins with Pre-Excavation site readiness scope then runs sequentially through Cavern & Drift Excavation phases 1, 2, and 3 to the Buildings & Site Infrastructure for the Ross Shaft Fit-out.
  - The schedule is constrained to optimize work performed based on the funding profile.
  - The schedule estimates presented were built upon an Arup provided detailed resource-loaded schedule for the construction scope.
  - FSCF construction scope is composed mainly of fixed-price contracts.
  - The construction contractor will be required to provide a cost-loaded baseline schedule and follow scheduling best practices. FNAL will use interface milestones and cost-loaded summary tasks to incorporate this within their Performance Measurement Baseline (PMB).
  - The project will implement EVM practices on pre CD-2 work to allow for training and hands on experience with EVMS for the FSCF control account manager.
  - The project cannot demonstrate EVMS on CD-3a work at this time but several of the components are in place with a plan to implement fully by April 2016.

- **Risk/Contingency**
  - A thorough initial risk assessment has been completed and is being proactively used as a management tool to inform the plan and manage the risk portfolio. Risk assessment addresses:
    - Estimate bias and uncertainty
    - Risk events and analysis of the risk register
    - Top-down expert opinion allowances
    - "Unknown-unknowns"
  - Risk process incorporates DOE guidance, Fermi policies and procedures, and commercial best practices (e.g. PMI Practice Standard)
  - Risk mitigation plans have been formulated and implemented, as appropriate, with clear ownership and accountability
  - Total project contingency at $342.8M is 34% of Budget to Complete
    - CD-3A funding of $302M includes $83M in contingency (38%)
  - Scope contingency of up to $40M had been identified
    - Primarily elimination of caverns 3 and 4 ($17M each)

Comments

- The committee found the CD-3a preliminary baseline to be complete, comprehensive and appropriate for this stage of the project design.
- Random drill-downs into the cost and schedule estimates demonstrated that each element was well understood by the CAM and supported with detailed documentation.
- Further development is needed to implement EVM on the Far Site Conventional Facilities scope to comply with the certification requirements, and a detailed plan exists outlining the work required to implement fully compliant EVM.
- Further development is needed regarding the incorporation of the GC schedule and the investigation of how best to utilize schedule margin. This may provide a more accurate alignment of the activities with the performance measurement baseline and DOE reporting milestones
- The impact of eliminating scope contingency on achievement of KPPs is not clear.

- **Recommendations**
  - Consider the use of schedule margin during the creation of the CD-3a baseline.
  - Successfully complete an EVM implementation review prior to award of the first construction sub-package.
  - The Project is ready to proceed to CD-3a.

5. Cost and Schedule

A. Bampton, PNNL / J. Fortner, ANL/
J. Post, LLNL

PROJECT STATUS as of 10/2015		
Project Type	Line Item	
CD-1	1Q/2013	10-Dec-2012 (A)
CD-1R	1Q/2016	5-Nov-2015 (A)
CD-3a	2Q/2017	
CD-3b	2Q/2020	
CD-2/ 3c	1Q/2021	
CD-4	4Q/2030	
TPC Percent Complete	10%	10%
TPC Cost to Date	$108M	
TPC Committed to Date	$112M	
TPC	$1,457M	
TEC	$1,359M	
Contingency Cost (w/Mgmt Reserve)	$342M	34%
Contingency Schedule on CD-4	40 months	29%
CPI Cumulative	N/A	
SPI Cumulative	N/A	

Findings

- **Very seasoned, experienced and capable project team in place.**
- **Project continues to receive very strong support from FNAL; stated to be "the highest priority at Fermilab."**
- **DUNE collaboration continues to grow: approx. 800 members from 27 countries. More formal management structure now in place.**
- **Increased success in obtaining support from outside sources including SDSTA, and CERN.**
- **As planned, LBNF/DUNE will meet P5 requirements.**
- **5 key management hires have been made since July. The most critical being the Project Director.**
- **The project team has implemented an Interface Control Document (ICD) system for overall configuration control.**
- **The project is carrying $40M scope contingency. If implemented, the remaining scope would not meet P5 requirements.**

Findings

- **Project plans to hire a QA manager by June.**
- **Project plans to hire a Far Site EHS/Q coordinator 3 months prior to construction.**
- **The limited number of fulltime FNAL personnel at the Far Site are to be supplemented with SDSTA staff.**
- **The project team is looking to hire a CM/GC prior to final design to provide pre-construction services including constructability reviews.**
- **CM/GC will be required to have dedicated safety and QA persons on site.**
- **Project schedule is constrained by proposed DOE funding profile.**
- **The Far Site (FS) conventional facilities design is identified to be 50% complete.**
- **Far Site (FS) critical path work is cavern excavation.**
- **Tentative decision to use nearby "open cut" site for waste rock disposal.**
- **Change control log being used to track possible substantive project changes.**

Findings

- **A highly skilled Procurement Manager and a Procurement Document Specialist were hired 2 months ago.**
- **Matrixed procurement staff 100% assigned to project. Back office support provided by FNAL's centrally managed Procurement department.**
- **After the CM/GC subcontract is awarded in June 2016, the project will determine if there a requirement for a subcontract administrator to be assigned to South Dakota.**
- **Two additional members of the procurement staff will be hired in FY2017 and one more in FY2021.**

Comments

- **Excellent progress since last review.**
- **Recent key hires appear to be very well qualified. Congratulations!**
- **Project/Collaboration communication and overall relationship appear outstanding**
- **But…the project embodies organizational and managerial complexities that will require continuous attention.**
- **Project's disciplined approach to tracking proposed changes is noteworthy.**
- **Dedicated project EHS staff will likely be needed at SURF to ensure that EHS is being properly managed by CM/GC and subcontractors.**
- **It will take more then 3 months for Far Site EHS/Q coordinator to get up to speed.**
- **Project QA staff may need to be present full-time during periods of CD-3A work.**
- **The committee supports the project team's decision to implement EVMS on the FSCF scope of work.**
- **The logistics associated with taking materials underground in parallel with removing 800,000 tons of waste rock are critical and should be fully reviewed and evaluated using time studies to validate assumptions.**
- **The project team should revisit the scope contingency plan of removing excavation of caverns 3 and 4. (KPP/P5 requirements issue)**

Comments

- **For planning purposes, may want to consider Procurement attendance at Project Integration meetings.**
- **Considering the experience of the members of the acquisition chain and the size and scope of the LBNF/DUNE project, an increase in the purchasing and subcontracting approval authority is warranted to bring this project in-line with other DOE projects. Increasing the authority would significantly improve procurement's turn-around time.**
- **The CM/GC RFP should include clearly defined evaluation criteria to help ensure that bidders have a good understanding of evaluation requirements.**
- **The project should closely evaluate whether current plans include enough staff with the right skill mix to properly manage Far Site day-to-day construction work.**

Recommendations

- **Work with a goal of having a Far Site EHS/Q coordinator in place at least 6 months prior to start of pre-excavation.**
- **Re-evaluate the number of Far Site-resident project EHS staff that will be needed.**
- **Revisit and update the scope contingency plan prior to CD-3A.**
- **Request DOE approval of increased purchasing and subcontracting authority.**
- **Perform full review of CM/GC RFP, ensuring inclusion of clearly defined evaluation criteria, prior to its release.**
- **Prepare for a follow-on review to be held after the 30% final design is complete and prior to issuing the construction contract for pre-excavation.**

1. Is the Far Site Conventional Facilities (CF) design technically sound and sufficiently mature to support proceeding with procurement and initiation of initial civil construction activities? YES, however, a follow-on review should be conducted in Fall 2016. Does the design flow down from the requirements? YES. Have technical risks been appropriately addressed? YES. Has the interface definition between CF and the cryostat/cryogenic systems and CF and the detector, as well as the logistics of excavation, construction, and technical systems installation, been sufficiently developed? YES.

5. Is the project being effectively managed? YES. Is it properly organized and staffed to successfully execute project plans, especially as they relate to the initiation of Far Site construction activities? YES.

6. Has the project responded appropriately to recommendations from the last DOE review, in particular, in relation to the Far Site CF.

7. Is the project ready to seek approval of CD-3a to initiate Far Site construction? YES.

Ready to proceed to CD-3A